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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/517,728	12/07/2004	John F Wager III	245-65853-02	6025

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EXAMINER	
TRINH, THANH TRUC	
ART UNIT	**PAPER NUMBER**
1753	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/517,728	WAGER ET AL.	
	Examiner	Art Unit	
	Thanh-Truc Trinh	1753	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07 December 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-33* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-33* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *7/12/2004*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Specification

1. The abstract of the disclosure is objected to because it is the front page of international application publication.

Applicant is reminded of the proper language and format for an abstract of the disclosure.

The abstract should be in narrative form and generally limited to a single paragraph on a separate sheet within the range of 50 to 150 words. It is important that the abstract not exceed 150 words in length since the space provided for the abstract on the computer tape used by the printer is limited. The form and legal phraseology often used in patent claims, such as "means" and "said," should be avoided. The abstract should describe the disclosure sufficiently to assist readers in deciding whether there is a need for consulting the full patent text for details.

The language should be clear and concise and should not repeat information given in the title. It should avoid using phrases which can be implied, such as, "The disclosure concerns," "The disclosure defined by this invention," "The disclosure describes," etc.

Correction is required. See MPEP § 608.01(b).

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 11, 18-20 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 11 is indefinite because claim 1, from which claim 11 depends, is not drawn to n-layer of indium tin oxide, zinc oxide and tin oxide.

Claims 18-20 are rejected because they depend on claim 11.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

1. Claims 1-3, 8-12, 14, 16, 18-28 and 31-33 are rejected under 35 U.S.C. 102(b) as being anticipated by Menezes (US Patent 5286306).

Regarding claims 1 and 32, as seen in Figure 2, Menezes discloses a photovoltaic energy conversion device comprising a p-i-n double heterojunction structure that includes a polycrystalline p-layer (16), a polycrystalline i-layer (15), and a polycrystalline n-layer (14), wherein at least two of the p-layer, i-layer, and n-layer comprise a polycrystalline Cu material. (See col. 4 lines 33-68 bridging col. 5 lines 1-68).

Regarding claim 2, Menezes describes the p-layer, i-layer, and n-layer each comprise a polycrystalline Cu material. (See col. 4 lines 33-68 bridging col. 5 lines 1-68)

Regarding claim 3, Menezes describes the i-layer is lightly doped (See col. 5 lines 33-37), p-layer and n-layer are heavily doped (See col. 5 lines 1-48). Therefore,

the i-layer comprises an absorber layer, and the p-layer and the n-layer each comprise a window layer.

Regarding claim 8, Menezes describes the n/i/p heterojunction is annealed. (See col. 5 lines 46-47). Therefore the p-layer is produced by annealing, the i-layer is produced by annealing, and the n-layer is produced by annealing.

Regarding claims 9-11, Menezes describes the p-layer containing $CuISe_3$, i-layer containing $CuIn_xSeI_z$, and n-layer containing $CuInSe_2$. Therefore the p-layer, i-layer, n-layer comprise a common anion (Se). (See col. 4 lines 33-33-68 bridging col. 5 lines 1-68).

Regarding claim 12, Menezes describes the n-layer is formed from I-III-VI_2. (See Abstract). Copper (Cu) is in group I and sulfur (S) is in group VI of the Periodic Table. Therefore, Menezes teaches the n-type comprising Cu-III-S_2, or a copper sulfide compound.

Regarding claim 14, Menezes describes the n-layer comprises a copper selenide compound ($CuInSe_2$) and the i-layer is a copper trivalent metal selenide compound ($CuIn_xSeI_z$). (See col. 1 lines 6-15)

Regarding claim 16, Menezes describes the n-layer is formed from I-III-VI_2. (See Abstract). Copper (Cu) and tellurium (Te) are in groups I and VI of the Periodic Table, respectively. Therefore, Menezes does teach the n-type comprising Cu-III-Te_2, or a copper telluride compound.

Regarding claim 18, Menezes describes the n-layer is from I-III-VI_2. (See Abstract). Zinc (Zn) is in group I and oxygen (O) is in group VI of the Periodic Table. Therefore, Menezes does teach the n-type layer of zinc oxide (ZnO).

Regarding claim 19, Menezes describes the n-layer is formed from I-III-VI_2. (See Abstract). Copper (Cu) and Oxygen (O) are in groups I and VI of the Periodic Table, respectively. Therefore, Menezes teaches the n-type comprising Cu-III-O_2, or a copper oxide compound.

Regarding claim 21, Menezes disclose a photovoltaic device comprising a thin film of heterojunction n/i/p type (See Abstract), wherein the film thickness is less than 5 micron. (See col.3 line 59)

Regarding claim 22, Menezes describes the n-, i- and p-layers each comprise a common anion, selenium (Se). (See col. 1 lines 6-15)

Regarding claim 23, Menezes describes the n-layer is formed from I-III-VI_2, i-layer from I-III-VI-VII, p-layer from I-VI_3-VII. (See Abstract). In other words, Menezes teaches all the layers (n/i/p) in the photovoltaic energy conversion device contains material from group VI of the Periodic Table, including oxygen (O) and sulfur (S). Menezes teaches the limitation of the instant claim, therefore the reference is deemed to be anticipatory.

Regarding claim 24, Menezes describes the i-layer and the p-layer comprise a Cu material. (See col. 1 lines 6-15)

Regarding claims 25-26 and 33, Menezes discloses a photovoltaic energy conversion device comprising a p-i-n double heterojunction structure that includes a

polycrystalline p-layer ($CuISe_3$), a polycrystalline i-layer ($CuIn_xSe_yI_z$), and a polycrystalline n-layer ($CuInSe_2$), wherein each of the p-layer, i-layer, and n-layer comprise a common cation, Cu. (See col. 1 lines 6-15)

Regarding claims 27-28, Menezes describes each of the p-layer, i-layer, and n-layer comprise a common anion, Se. (See col. 1 lines 5-16)

Regarding claim 29, Menezes discloses a photovoltaic energy conversion device as described in claims 22 and 28 respectively, wherein the n-layer is formed from I-III-VI_2, i-layer from I-III-VI-VII, p-layer from I-VI_3-VII. (See Abstract). In other words, Menezes teaches all the layers (n/i/p) in the photovoltaic energy conversion device contains material from group VI of the Periodic Table, including oxygen (O) and sulfur (S). Menezes teaches the limitation of the instant claim, therefore the reference is deemed to be anticipatory.

Regarding claim 31, Menezes describe a method for making a thin-film solar cell, comprising depositing a p-type material, an intrinsic material, and a n-type material onto a substrate so as to form a p-i-n double heterojunction structure (See col. 4 lines 33-68 bridging col. 5 lines 1-68); and annealing the p-type material, intrinsic material, and n-type material to produce a polycrystalline p-layer, a polycrystalline i-layer, and a polycrystalline n-layer (See col. 5 lines 46-48), wherein at least two of the p-type layer, the intrinsic layer, and the n-type layer comprise a Cu material. (See col. 1 lines 6-15).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

2. Claims 4-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Menezes (US Patent 5286306) in view of Nishimoto (US Patent 6043427).

Regarding claims 4-5, Menezes describes a photovoltaic energy conversion device as described in claim 1.

Menezes does not teach the i-layer has a maximum majority carrier concentration of about $10^{17}/cm^3$, nor does he teach the i-layer has majority carrier concentration of about $10^4/cm^3$ to about $10^{16}/cm^3$.

Nishimoto teaches a photovoltaic device having a pin-structure semiconductor, wherein the dopant concentration (or majority carrier concentration) of the i-type semiconductor layer is $2 \times 10^{17}/cm^3$ or less. (See Claim 1 and 11 of Nishimoto)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Menezes by doping the i-layer with a concentration of about $10^{17}/cm^3$ or less as taught by Nishimoto, because it would give an excellent photoelectric conversion efficiency and a remarkable optical stability at an enhanced rated and at low cost. (See Abstract of Nishimoto)

3. Claims 6-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Menezes (US Patent 5286306) in view of Hasan et al. ("The optical and electrical properties of copper indium di-selenide thin films, Optical Materials, Vol. 14, Issue 4, 4 August 2000, pages 329-336).

Regarding claims 6-7, Menezes describes a photovoltaic energy conversion device as described in claim 1.

Menezes does not teach the p-layer and the n-layer each have a minimum respective carrier concentration of about $10^{18}/cm^3$, nor does he teach the p-layer and the n-layer each have a respective carrier concentration of about $10^{19}/cm^3$ to about $10^{21}/cm^3$.

Hasan et al. teach the carrier concentration (of either p-layer and n-layer) depends on the Cu/In ratios, the larger the ratio the higher the carrier concentration. (See Fig. 5 on page 333). Hasan et al. also teach in the case of Cu-rich, the carrier concentration can be greater than $10^{17}/ cm^3$. (See table 3 on page 335). Therefore, Hasan et al. do teach the limitations of the instant claims.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Menezes by doping the p-layer and n-layer with concentration greater than $10^{17}/cm^3$ as taught by Hasan et al., because it would increase the conductivities. (See col. 1 of page 333).

4. Claims 13 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Menezes (US Patent 5286306) in view of Zhang et al. ("Sulfur p-band hole generation in β-$BaCu_2S_2$. Synthesis of metallic $K_xBa_{1-x}Cu_2S_2$ from molten mixed Ba polysulfide salts", Journal of Alloys and Compounds, Volume 236, Number 1, 1 April 1996, pages 1-5)

Menezes disclose a photovoltaic energy conversion device as described in claim 12.

Menezes does not teach the p-layer is selected from a divalent metal copper sulfide compound, a divalent metal copper sulfide fluoride compound, a divalent metal copper sulfide oxide compound, a trivalent metal copper sulfide compound, a trivalent metal copper oxide sulfide compound, a trivalent metal copper sulfide fluoride compound, a quadrivalent metal copper sulfide compound, a quadrivalent metal copper sulfide oxide compound, a quaddvalent metal copper sulfide fluoride compound and mixtures thereof. Menezes also does not teach the n-layer comprises MCu_2S_2 or MCuSF wherein M is selected from Ca, Sr, Ba.

Regarding claim 13, Zhang et al. teach a p-type semiconductor layer being divalent metal copper sulfide compound ($BaCu_2S_2$). (See Introduction of Zhang et al.).

Regarding claim 30, Zhang et al. teach that $BaCu_2S_2$ semiconductor can be doped with different material to achieve high-Tc copper oxide superconductors. (See col. 1, 2nd paragraph of page 4)

It would have been obvious to one having ordinary skill in the art at the time the invention was to modify the device of Menezes by providing a p-layer of $BaCu_2S_2$ as taught by Zhang et al., because it would give a high-Tc copper oxide supperconductor. (See Introduction).

It would certainly obvious to one skill in the art to dope the semiconductor with different type of dopant to achieve different kind of semiconductor, either an n- or a p-type.

5. Claims 15, 17, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Menezes (US Patent 5286306) in view of Switzer (US Patent 4492811)

Menezes discloses a photovoltaic energy conversion device as described in claims 14, 16 and 19.

Menezes does not teach the p-layer is selected from a copper divalent metal selenide compound, a copper divalent metal selenide fluoride compound, a copper divalent metal selenide oxide compound, a copper trivalent metal selenide compound, a copper trivalent metal selenide fluoride compound, a copper trivalent metal selenide oxide compound, a copper quadrivalent metal selenide compound, a copper quadrivalent metal selenide fluoride compound, a copper quadrivalent metal

selenide oxide compound and mixtures thereof. Nor does he teach the p-layer is selected from a copper divalent metal telluride compound, a copper divalent metal telluride fluoride compound, a copper divalent metal telluride oxide compound, a copper trivalent metal telluride compound, a copper trivalent metal telluride fluoride compound; a copper trivalent metal telluride oxide compound, a copper quadrivalent metal telluride compound, a copper quadrivalent metal telluride fluoride compound, a copper quadrivalent metal telluride oxide compound and mixture thereof. Menezes also does not teach the p-layer is selected from a copper divalent metal oxide compound; a copper divalent metal oxide fluoride compound, a copper trivalent metal; oxide compound, a copper trivalent metal oxyfluoride compound, a copper quadrivalent oxide compound, a copper quadrivalent oxide fluoride compound and mixtures thereof

Regarding claim 15 and 17, Switzer teaches a semiconductor material having structure I-III-VI_2, particularly $CuInSe_2$ and $CuInTe_2$ (See col. 3 lines 45-47). $CuInSe_2$ and $CuInTe_2$ are a copper trivalent metal selenide and copper trivalent metal telluride compounds. Switzer also teaches the semiconductor material can be either p- or n-type depending on the dopant. (See col. 3 lines 33-35)

Regarding claim 21, Switzer teaches a semiconductor material having structure I-III-VI_2 (See col. 3 lines 45-47), which can be either p- or n-type depending on the dopant (See col. 3 lines 33-35). As seen in the Periodic Table, oxygen is in the same group VI with Se and Te. Therefore, it is the Examiner's position that Switzer teaches copper trivalent metal oxide compound as well.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Menezes by provide a p-layer of I-III-VI_2, such as $CuInSe_2$ or $CuInTe_2$ or $CuInO_2$ as taught by Switzer, because it would give a relative high cell efficiencies. (See col. 7 lines 57-60).

In addition, it would certainly have been obvious to one skill in the art to use either p-type or n-type ternary semiconductor material I-III-VI_2 such as $CuInSe_2$ (copper trivalent metal selenide) $CuInTe_2$ (copper trivalent metal telluride) or $CuInO_2$, (copper trivalent metal oxide) because it is well known in the art of photovoltaic device.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh-Truc Trinh whose telephone number is 571-272-6594. The examiner can normally be reached on 8:30 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen can be reached on 571-272-1342. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

TT
8/2/2007

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